THE CONCEPT OF BASIC CHROMOSOME NUMBERS IN CHAROPHYTA – A REVIEW

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RÉSUMÉ. – Une révision des nombres chromosomiques de base est proposée chez trois genres de Charophycées (*Chara*, *Nitella* et *Tolypella*). Les nombres de base x = 7 (tribu des Chareae), x = 3 (genre *Nitella*) et x = 5, 8 et 11 (genre *Tolypella*) confirment le schéma évolutif publié par SAWA (1974).

ABSTRACT. – The basic chromosome numbers in three Charophyte genera viz. *Chara*, *Nitella* and *Tolypella* have been reviewed and the base numbers x = 7 (tribe Chareae), x = 3 (genus *Nitella*) and x = 5, 8 and 11 (genus *Tolypella*) have been ascertained upholding the hypothetical schema of their origin as propounded by SAWA (1974).

INTRODUCTION[1]

Charophyta, a widely occurring group of macrophytic algae, has undergone extensive cytological and cytotaxonomic investigations throughout the globe. A large number of polyploids came into existence and the basic chromosome numbers were assigned to them. The basic chromosome numbers in Charophytes particularly are of much concern in deciding the specific status of various forms and in tracing the interrelationships and phylogeny of this group.

Tribe Chareae and tribe Nitelleae are two cytologically separated groups of Charophyta. The former is characterized by the basic chromosome number x = 7 (and its multiples) While the later is characterized by x = 6 (and its multiples) for anathrodactylous and x = 9 (and its multiples) for arthrodactylous forms.

WOOD & IMAHORI (1965) have categorized the tribe Nitelleae into three subgenera viz. *Nitella*, *Tieffallenia* and *Hyella*. The subgenus *Nitella* is characterized by the basic number x = 6 (and its multiples) except in *Nitella mirabilis*

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n = 9 (RAMJEE & BHATNAGAR, 1978 a); *N. stuartii*, n = 15 (SARMA & KHAN, 1965) and *N. acuminata* f. *belangeri*, n = 29 (RAMJEE & BHATNAGAR, 1978 b) whereas the subgenera *Tieffallenia* and *Hyella* are characterized by x = 9 and its multiples except in *N. tenuissima* f. *transilis*, n = 21, *N. hyalina* n = 21 (Both BHATNAGAR, unpublished) and *N. pseudoflabellata* var. *mucosa* f. stabilis, n = 21 (MUKHERJEE, 1978).

DISCUSSION

1 — Genus CHARA

This genus comprises the corticated and the ecorticated forms, for which a large number of chromosome counts have so far been recorded from India and other countries of the world.

The Indian subcontinent exhibits a large number of euploid forms and the aneuploid chromosome number in Indian Charophyta is of rare occurrence unlike European Charophytes.

The euploid series of chromosome numbers n = 7, 14, 28, 35, 42, 49, 56 and 70 has been reported from various countries along with the few aneuploids of n = 8, 16, 19, 24, 26, 37, ca 40 and 48 for the genus *Chara*.

The basic chromosome number for the genus *Chara* was first suggested by MOUTSCHEN, DAHMEN & GILLET (1956) as «7» which was supported by BHATTACHARYA (1972), GILLET (1959), GUERLESQUIN (1961 a, 1967), HOTCHKISS (1958, 1963, 1964), IMAHORI & KATO (1961), KAHN & SARMA (1967), SARMA (1973) and SINHA & VERMA (1976). The concept of basic chromosome number x = 7 for the genus *Chara* received a concrete support by the reports of n = 7 in *Chara braunii* (SARMA & KHAN, 1965; NOOR & MUKHERJEE, 1977; SINHA & VERMA, 1969 CHATTERJEE, 1976) and *Chara vulgaris* subsp. *eu-vulgaris* (GUERLESQUIN, 1967) from India and France respectively. SINHA & VERMA (1969) called it a natural polyploidization. CHATTERJEE (1976) reported two groups of «7» chromosomes in a «14» chromosome cell and explained it as a somatic reduction in *Chara braunii*.

The author has reported the chromosome numbers n= 14, 28, 42 and 48 from various places in India, out of which n = 48 (*Chara zeylanica* f. *elegans*) is an aneuploid for the genus *Chara* (cf. RAMJEE & BHATNAGAR, 1978 b). Other aneuploids which have been reported from the Indian subcontinent are *Chara hydropitys* with n = 8 (NOOR & MUKHERJEE, 1975), from Bihar and *Chara gymnopitys* with n = 37 (CHENNAVEERAIAH & BHARATI, 1974) from Mysore State. The present findings, being in multiples of «7», support the basic chromosome number x = 7 in the genus *Chara*.

2 — Genus NITELLA

The euploid series of chromosome numbers n = 6, 9, 12, 15, 18, 21, 24, 27, 36, 48, and the aneuploid series of n= 14, 16, 17, 28 and 34 have been recorded

so far from India and abroad but the only aneuploid in the genus *Nitella* reported so far from India is *Nitella acuminata* f. *belangeri* with n = 29 (RAMJEE & BHATNAGAR, 1978 b).

GILLET (1959) suggested x = 6 as the basic chromosome number for the genus *Nitella*. GUERLESQUIN (1961 a, 1967) has however suggested «6» and «7» as the basic chromosome numbers for this genus. HOTCHKISS (1963, 1964) supported the views of GILLET (1959) and proposed an additional basic chromosome number x = 9 for arthro- and anarthrodactylous forms of *Nitella*.

SARMA et al. (1970) confirmed the view of HOTCHKISS (1963) and concluded that anarthrodactylous *Nitella* (subgenus *Nitella*, dactyls 1-celled) and arthrodactylous *Nitella* (subgenus *Hyella* and *Tieffallenia*, dactyls more than 1-celled) have x = 6 (or its multiples) and x = 9 (or its multiples) respectively. But the occurrence of «9» chromosomes in an anarthrodactylous form *Nitella mirabilis* (RAMJEE & BHATNAGAR, 1978 a) has however contradicted the above generalisation. Later on, SARMA & KHAN (1964) suggested x = 3 as the basic chromosome number for the genus *Nitella* on the basis of karyotypic analysis of *N. mirabilis* (n = 6). This view received a big support from SARMA & KHAN (1965), KHAN & SARMA (1967), SARMA (1968, 1973), RAMJEE (1969), NOOR & MUKHERJEE (1977), MUKHERJEE (1978) and RAMJEE & BHATNAGAR (1978 a) because the occurrence of chromosome numbers n = 9, 15, 21 and 27 in *Nitella* can only be explained by considering x = 3 as the basic chromosome number for this genus.

The author has reported n = 6 (in *N. mirabilis*), 9 (in *N. mirabilis* and *N. dualis* var. *pulchella* f. *superba*), 18 (in *N. acuminata*, *N. furcata* complex (cf. RAMJEE and BHATNAGAR 1978 c), *N. hyalina*, *N. translucens* var. *axillaris*), n = 21 (in *N. hyalina*) and 36 (in *N. furcata* complex, see RAMJEE & BHATNAGAR (1978 c), *N. pseudoflabellata*, *N. axillaris*) in various forms of the genus *Nitella* (all in multiples of «3»), thus upholding the views of x = 3 as the basic chromosome number for this genus.

3 — Genus TOLYPELLA

A large number of *Tolypella* species have been worked out from European countries by LINDENBEIN (1927), CORILLION (1960, 1961), CORILLION & GUERLESQUIN (1959), GUERLESQUIN (1961 a et b), 1963, 1964, 1967, 1977) and BHATTACHARYA (1972) recording chromosome numbers n = 10, 15, 20, 25, ca 20 and 50 (all in multiples of «5») except n = 9, 11, 12, 42 in few species of *Tolypella*. The basic chromosome number x = 5 was therefore suggested by these workers for this genus.

But HOTCHKISS (1966) had revisted the basic chromosome number for *Tolypella* as x = 11 which has been supported largely by SARMA & RAMJEE (1969), SAWA (1973, 1974) and RAMJEE & BHATNAGAR (1978 b). SAWA (1973, 1974) reported n = 33 (in *T. glomerata* and *T. comosa*) and n = 11 (in *T. intricata* and *T. prolifera*) while SARMA & RAMJEE (1969) and RAMJEE & BHATNAGAR (1978 b) observed n = 11 in *Tolypella prolifera* and *T. glome-*

rata respectively from India.

Simultaneously, a chromosome count of n = 8 (in *T. boldii* and *T. canadensis*) by SAWA (1973, 1974) appeared as an exception to the series of x = 11 and its multiples. Since the occurrence of n = 8 cannot be justified by any of the basic chromosome numbers reported so far, this chromosome number may also be considered as a new base number for the genus as suggested earlier by SAWA (1974) but it requires more experimental verifications.

Thus the three basic chromosome numbers viz. x = 5, 8, 11 have been suggested for the genus *Tolypella*.

ORIGIN OF BASIC CHROMOSOME NUMBERS IN CHAROPHYTES

GUERLESQUIN (1967) realised that the basic chromosome numbers in ancestral forms of Charophytes were in the multiples of «7» or x = 7 and the loss of «1» chromosome has resulted into x = 6, the basic chromosome number for the genus *Nitella*. Further loss of «1» chromosome from x = 6 has given rise to x = 5 as the basic number for the genus *Tolypella* but the origin of recently established basic numbers x = 3 and 11 for the genera *Nitella* and *Tolypella* respectively could not be explained by this hypothesis.

SAWA (1974) propounded a more convincing scheme for the origin of basic chromosome numbers in Charophytes. He considered x = 3 as the ancestral chromosome number from which the tribe Chareae, the genus *Nitella* and the genus *Tolypella* have diverged by aneuploidization. He emphasized the occurrence of three basic chromosome numbers in *Tolypella* viz. x = 5, 8 and 11 thus differentiating the North American taxa and Indian taxa (having basic chromosome numbers x = 8 and 11) from the European taxa (having x = 5). SAWA (1974) also studied the effect of salinity on charophytes.

SAWA (1974) refuted the merger of the genus *Tolypella* in the genus *Nitella* as a section of the later and suggested more affinities of *Tolypella* with the tribe Chareae than with the genus *Nitella* on morphological and anatomical grounds. The author's report of n = 11 in *Tolypella glomerata* from India (RAMJEE & BHATNAGAR, 1978 b) confirms the views of SAWA (1974) and also supports the scheme of the origin of basic chromosome numbers propounded by him.

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